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AREAS OF SEAL R&D AT GE

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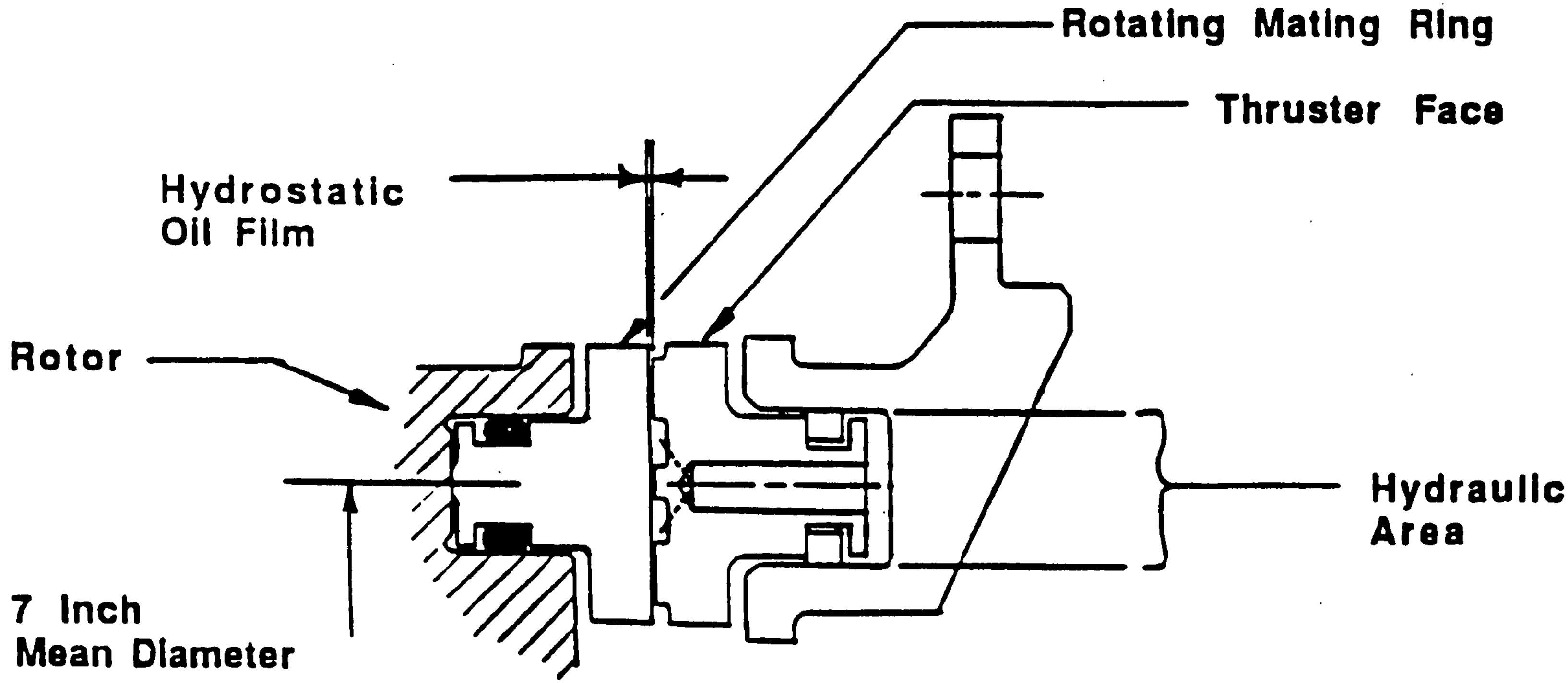
About four years ago, work was completed on a 36 inch diameter gas to gas carbon ring seal used to buffer low pressure turbine air at the rim of the forward outer flowpath on the GE36 unducted fan (UDF) engine. This highly successful program demonstrated the ability to provide long life at a gas leakage rate equivalent to a .0018 inch clearance, or, conservatively estimating, a 20 to 1 reduction over a labyrinth, and an SFC reduction of at least 2.5%. Operating conditions were 1600 rpm (240 fps), 60 psid and 650 deg F. The seal design was based on the use of self-acting gas hydrostatic bearings.

At about the same time, we were working an AF/Navy contract for development of a long life counter-rotating intershaft air-oil seal of approximately 7.6 inch diameter for operation at 800 fps, 800 deg F and 50 psid. Although we were successful in meeting most program goals with a split ring seal of the axial bushing type, the seal with the greatest payoff in life and air leakage rates, bearing many features common with the GE36 seal, could not be successfully tested because of the structural weakness of the primary seal ring carbon material. This was a split ring seal using a hybrid combination of orifice compensated hydrostatic and shrouded hydrodynamic gas bearings. We are presently working an AF contract to develop this design in conjunction with high strength carbon materials being developed by Pure Carbon Co.

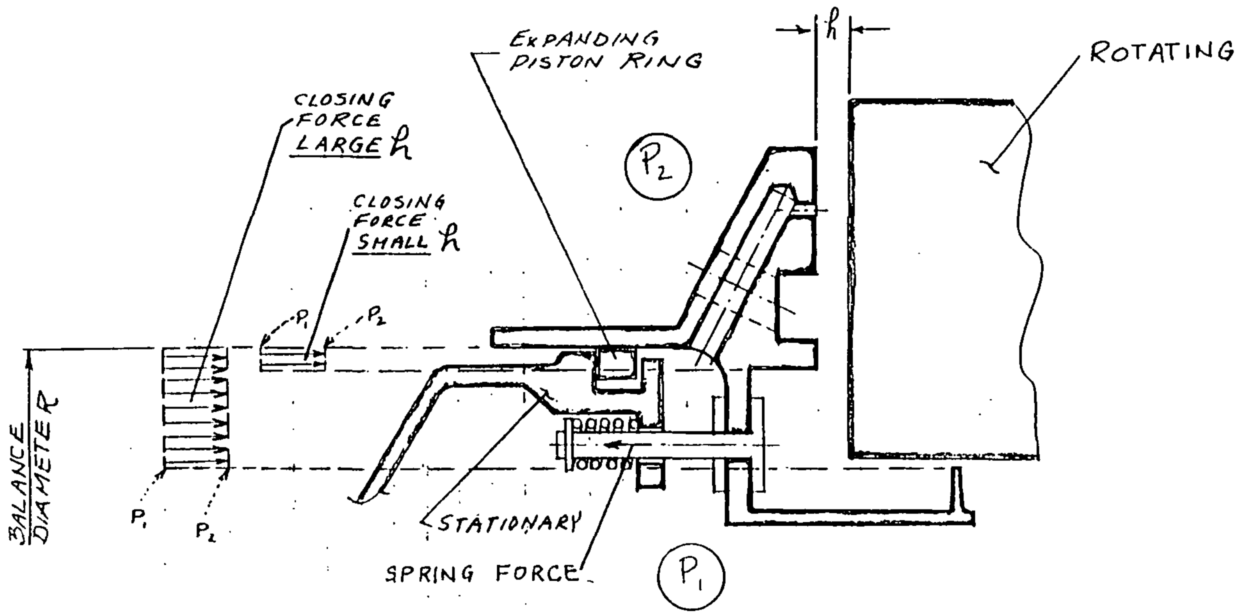
In the area of engine secondary gas flow path sealing for performance improvement, we are currently working with carbon and all metal face seals. Nine inch diameter hydrodynamic carbon face seals at 450 fps, 140 psid and 950 degrees F, have demonstrated long life at a flow reduction of approximately 96% (7.5 scfm) compared to a "best" labyrinth. A fifteen inch diameter all metal "aspirating" face seal, using self-acting hydrostatic bearings, has been successfully tested to 700 fps, 100 psid and 1000 deg F, demonstrating long life at a flow reduction of 86% compared to a "best" labyrinth. This seal will be developed through 1400 deg F, 900 fps and 350 psid. The seal "aspirates" closed at about idle speed pressure during engine start and reopens at engine shutdown.

A hydraulic thrust balance "seal", currently using orifice compensated hydrostatics, is under development. We have demonstrated long life operation for most large engine low pressure rotor applications (170 fps) with 30000 pounds control at 7 inches diameter and less than 3 gpm flow rate using Type 2 (23699) engine oil. We are now working high pressure rotor systems, to 450 fps. This program has two significant payoffs: 1) as much as 50 to 1 increase in thrust bearing fatigue life, 2) as much as 3% reduction in SFC and significant multipliers in turbine bucket life.

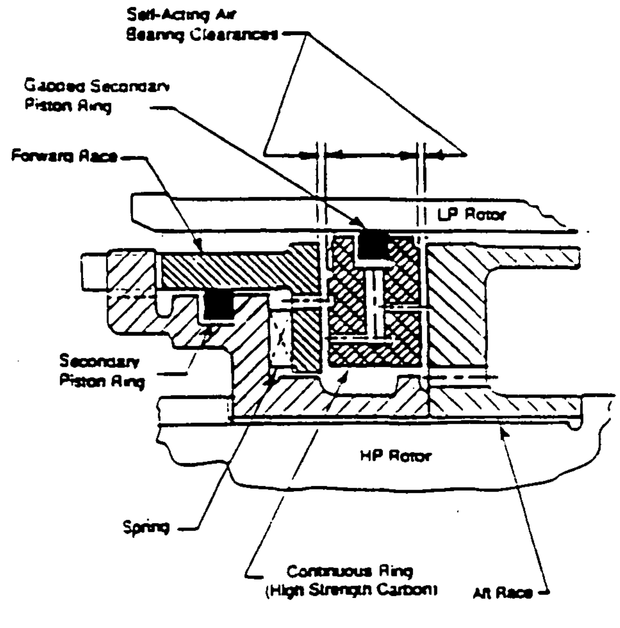


CROSS SECTION OF A 7 INCH HYDRAULIC THRUST CONTROL.

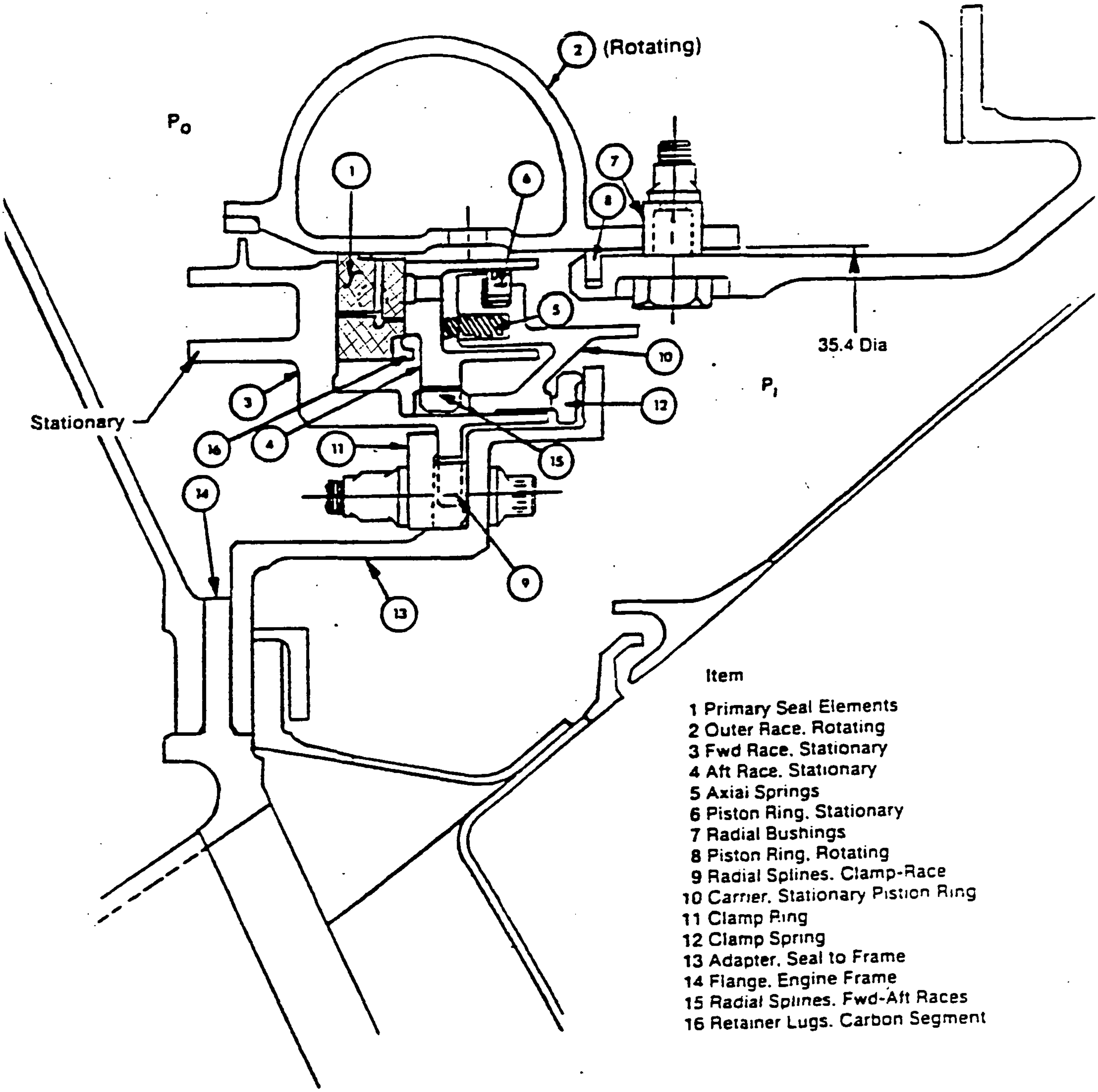
An axial force is transmitted to the engine rotor by applying oil under pressure to the hydraulic area of the thrust control mechanism.



ASPIRATING GAS BEARING FACE SEAL



CONTINUOUS RING SEAL DESIGN



LARGE DIAMETER HYDROSTATIC SEAL